

GERMINATION OF *PINUS ARISTATA* ENGELM.

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ABSTRACT.— Seeds of *Pinus aristata* Engelm., bristlecone pine, from the type locality at the headwaters of Clear Creek in Colorado have a germination of 80 percent. Germination occurs within 10 days with or without vernalization. Scarified seeds are invaded by fungus and less than 10 percent germinate. Seedlings 10 and 180 days old do not survive exposure to -10C (14F) even when exposed to gradually decreasing temperatures to -4C (25F) for five weeks before treatment. Rapid germination, scarification mortality, and lack of cold hardness in seedlings work against the reproduction of bristlecone pine.

In a recent study of the *Pinus* subsection *Balfourianae* (the fox-tail pines) Bailey (1970) described the eastern California and Nevada populations of *P. aristata* Engelm. as a new species, *P. longaeva* Bailey. A review of the literature shows that nearly all botanical work on *P. aristata* has used material from the far western populations now defined as a separate species. The Great Basin and Rocky Mountain populations—retained as *P. aristata*—remain virtually unstudied.

In Colorado, bristlecone pine occurs in rather small, pure, open stands scattered throughout the south central and southwestern parts of the state. The stands are found between 2500 meters (Cochetopa Pass) and 3700 meters (Cumberland Pass), most frequently on the gravelly soil of south- or west-facing slopes. This paper is part of an analysis of *P. aristata* from the type locality—the headwaters of Clear Creek in Colorado—and examines the germinability of the seed in an effort to understand the limited occurrence of this pine.

Seeds used in the study were collected from the north and east slopes of Mount Evans at an altitude of 3000 meters during October 1970. Germination tests were started during April 1971.

SEED MORPHOLOGY.— The seed of *P. aristata* is typical of the genus *Pinus* (Martin and Barkley, 1961). The wing shows wavy, fingerprint-like lines. The testa has a mottled, dark brown surface and a papery brown nucellus. The length of the seeds with wings averages 16 mm. Seeds in a sample of 100 weighed an average of 24.5 mg with wings and 22.4 mg without wings.

One hundred seeds were opened; 88 had a firm, white endosperm and a pale yellow, well-defined embryo, with from 7 to 12 cotyledons. The 12 seeds without healthy embryos contained only a flake of dry tissue.

IMBIBITION.— Fifty seeds with wings removed were submerged in distilled water. At intervals they were removed, blotter dried, and weighed. Initial water uptake was rapid: 18 percent during the first hour. The weight gain continued at a reduced rate through germination (Fig. 1).

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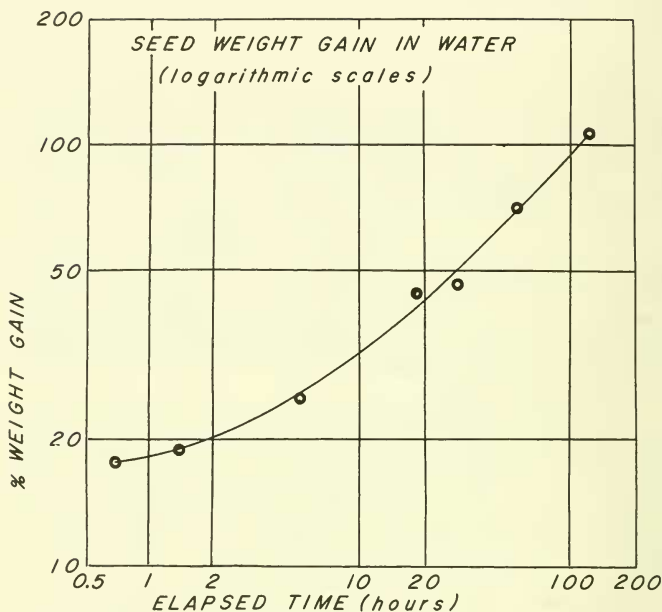


Fig. 1. Imbibition of *Pinus aristata*: percentage weight gain in water as a function of time since immersion.

GERMINATION.— Forty seeds were placed on moist filter paper in petri dishes. Twenty were scarified by making a shallow 2-4 mm long cut on the flat side of the seeds. All of these scarified seeds were quickly invaded by fungus and none germinated. Of the 20 unscarified seeds, 15 (75 percent) germinated.

One hundred seeds were planted 10 mm deep in clay pots with four parts sand to one part peat moss. Of these, 80 were exposed to -10C (14F) for 100 hours prior to planting. Thirty-two of these were scarified as described above. All of the seeds had been collected in October and had, no doubt, been exposed to subfreezing temperatures prior to collection.

Germination occurred rapidly, with the first plants appearing during the 4th day, and no additional plants occurring after the 10th day. Of 20 planted as collected, 16 (80 percent) germinated. Of those vernalized but not scarified, 37 (77 percent) germinated, and only 3 (8 percent) vernalized and scarified seeds germinated. All of the seedlings not used for experiments were alive 60 days later.

COLD HARDNESS.— Four 14-day-old seedlings were exposed to -10C (14F) for 2 hours. All wilted and died. Six 180-day-old plants were placed in a growth chamber set for a 12 hour day, a day temperature of 13C (55F), and a night temperature of 7C (45F). Over a period of 14 days, the day temperature was reduced to 2C (36F). The day length was reduced to 9 hours. These temperatures were maintained for another 21 days.

Three of the pine seedlings were then put into a plastic bag to reduce dehydration and were placed in a freezer at -10C for 48 hours. The plants were then returned to the growth chamber and the temperature increased to 20C (68F). Those which had been in the freezer browned in 5 days and died.

DISCUSSION.— The tests suggest the following:

1. *P. aristata* germinates rapidly with a high yield (ca. 80 percent);
2. less than 10 percent of the seeds will germinate if they have been scarified;
3. the seeds do not require long cold treatment prior to germination;
4. seedling bristlecone pine is sensitive to freezing and is killed by exposure to -10C (14F).

The seeds and seedlings of *P. aristata* do not appear to be well adapted to the climate found in their habitat in Colorado. At tree line, frost and snow can occur any month of the year. In the fall, severe storms followed by warm weather and a thaw are frequent, and the spring is often an irregular series of sunny days and heavy snows lasting into June (Marr, 1961). All of these factors work against the successful reproduction of this pine. The rapid germination must cause the death of many seedlings after thaws, and those growing in temporarily moist locations must often desiccate and die. In spite of these disadvantages, *P. aristata*, a pine that lives as much as 800 years in Colorado, has survived without morphological change in this area since the Miocene (Bailey, 1970).

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